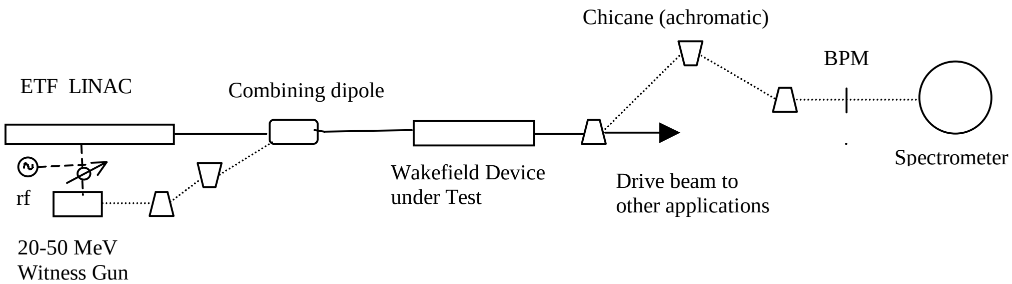
A HIGH RESOLUTION WAKEFIELD MEASUREMENT SYSTEM FOR THE ETF

Wei Gai and Paul Schoessow
High Energy Physics Division
Argonne National Laboratory

Given the existence of a 1-2 GeV low emittance electron beam at ETF, it would be very straightforward to devise a flexible and economical wakefield measurement system which would exceed the longitudinal and transverse resolutions available at ASSET. This would be extremely useful for direct diagnosis of the parasitic wakefields in linear collider accelerating structures. One possible concept, based on our wakefield measurement experience at the ANL AATF and AWA facilities, is shown below:



The beam from the ETF main linac would be combined with a low energy witness beam and passed through the cavity under test. A chicane is used to steer the drive beam to other downstream experiments and meanwhile preserve the transverse deflection received by the witness beam in the test cavity. The transverse deflection of the witness beam is measured using a BPM, and its energy change is measured in a dipole spectrometer. By changing the relative phase of the witness gun rf relative to the drive linac, the relative delay of the witness beam with respect to the drive beam can be varied and the wake potential for the cavity being tested can be mapped out. By measuring the witness deflection for different offsets of the drive beam from the axis of the cavity, the contribution to the deflection from individual modes of different azimuthal symmetries (dipole, quadrupole…) can be determined. The drive beam offset through the test device can be varied either by changing the beam optics upstream of the test device or mounting it on an adjustable stage.

It is worth noting that the witness beam requirements are fairly modest. The witness intensity would be ≈ 1 pC to avoid space charge effects, and the bunch length about 0.5 mm. It would not be necessary to use a photoinjector; a thermionic gun would work as well.

Because of the large energy difference between the drive and witness beams, very high resolutions can be obtained. We expect to achieve angular sensitivity of ~ 10^{-6}, with a transverse wakefield resolution of 0.01 eV/pC/mm. This resolution can be further improved with better BPM resolution (we assumed 10 μm) and a longer drift section (10 m) between the chicane and the BPM.

This system would provide a unique capability for ETF. Better resolutions can be obtained than at ASSET, without any interruption of the operations of a high energy physics machine. We believe that this approach is seriously worthy of consideration.